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Effects of Different Levels of Dietary Oils on Growth Performance and Fatty Acid Proportion of Steaks from Sarabi Steers

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Abstract: An experiment was conducted to evaluate effects of diet supplementation with vegetable oils sources on bulls performance and fatty acid (FA) proportion of steaks. Twenty one Sarabi steers (200±20 kg BW) were assigned in seven treatment, fed diets containing 0% oil (control), 2 and 4% of canola oil (CO), sunflower oil (SO) and restaurant waste oils (RWO). Ribeye steaks from steers fed CO, SO and RWO for 90 days of experiment were used after slaughtering to evaluate the effects of oil source on fatty acid profile. Fattening bulls fed 2% oils and control tended to have greater dry matter intake (DMI) as compared with those fed 4% oil (P <0.05). The highest daily weight gain (DWG) was observed in 2% RWO, followed by 2% SO dietary groups, but differences were not significant. The SFAs contents of steaks of bulls fed diets supplemented with 2% CO did showed the lowest value and followed by 2% SO dietary groups. Steaks from bulls fed 2% CO and SO had highest aggregation of polyunsaturated fatty acids (PUFA, 52 and 53%, respectively) and lowest saturated/polyunsaturated FAs ratio (0.647 and 0.753, respectively).

Key words: Oil · Performance · Fatty Acid and Sarabi Steer

INTRODUCTION

Previous studies demonstrated that fatty acid composition of bovine tissues can be influenced by dietary regimens [1, 2]. In ruminants, altering tissue fatty acid composition is difficult because unsaturated fatty acids are extensively biohydrogenated by rumen microorganisms [3]. Previously, it was demonstrated that incorporation of dietary PUFA into edible tissues indicate that at least a portion of fatty acids can escape biohydrogenation by ruminal microorganisms [1, 4]. Casutt *et al.* [5] observed increased concentrations of α-linolenic acid in adipose tissue of Brown Swiss bulls fed flaxseed and Focant *et al.* [6] demonstrated that feeding linseed oil (LO) to lactating dairy cows increased n-3 fatty acids deposition in soft tissues. Notable effects of n-3 fatty acids in human diets include improved immunity [7], reduced risk of cardiovascular disease [8], and anti-inflammatory relief for rheumatoid arthritis [9, 10]. Given the potential health benefits associated with consumption of n-3 fatty acids, increasing the concentration of α-linolenic acid in edible tissues of beef could provide an alternative means of increasing intake of these fatty acids. Thus, inclusion of PUFA-rich plant oil or whole seeds in ruminant rations was shown in several studies [11-13] to increase the concentration of CLA and PUFA in meat, despite the extensive biohydrogenation of dietary lipids within the rumen. However, many studies are necessary for well detecting the efficacy of oil supplementation to the n-3 PUFA concentrations in tissue [14, 15].

The objectives of this experimental investigation were to determine the effects of dietary differences in vegetable oil sources on performance and fatty acid proportion in Sarabi steers.

MATERIALS AND METHODS

To minimize differences in gastrointestinal fill, 21 Sarabi steers (384 kg BW±17 kg) were adapted to a common diet based on dry-rolled corn for 17 d before the experiment was initiated. Animals were divided by initial BW and allotted, within strata, to 7 experimental treatments, with a total of 3 steers per treatment. The experiment was conducted as a randomized complete-block design with each animal as the experimental unit.

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Dietary treatments were: 0% oil (control), 2% canola oil (CO), 2% sunflower oil (SO), 2% restaurant waste oils (RWO), 4% CO, 4% SO and 4% RWO. The experimental oils added to concentrates of the same diet containing 5.2 kg hay, 1.2 kg corn silage and 2 kg concentrate (171 g CP/Kg DM) that were fed to each of steer in each day. Corn silage and hey was fed at 14:00 h daily and the concentrates in two equal portions at 09:00 h and 16:30 h.

Steers were implanted with Component-TES (Vetlife, Inc., Norcross, GA) and placed into individual pens and fed their respective diets once daily to allow *ad libitum* consumption for 90 d. Bulls were weighed every week and data on weekly food intake, food conversion ratio (FCR) and daily weight gain (DWG) were recorded in each replicate group and the body weight (BW) presented as growth performance at the end of trial.

On day 90, steers were individually weighed and transported to a commercial slaughter facility and after which carcass data were obtained. Following a 24 h chill, wholesale ribs were removed from the left side of each carcass. Ribs were sealed in vacuum packages and aged for 2 d at 4°C. Steaks (1 steak per side; 2.54 cm thick) were cut from the posterior end of the rib and were used for the following analyses: fatty acid composition or other meat characteristics. Similar locations within the steaks were utilized for common assay.

Chemical Analysis: A ribeye steak from each steer was coarsely ground through a plate grinder and subsampled. FA composition were extracted in ribeye samples (1g) with a 1 chloroform: 2 methanol (v:v) according to the method of Folch *et al.* [16] Separation of fatty acid methyl esters in meat samples was performed by a Gas Chromatography (Italy), equipped with a flame ionization detector, data processor (GC-1000, Dany), hydrogen generator (Glaind-2200, Italy) and a split-splitless injector on an Altech Econo-Cap, EC-1000 capillary column (30 m × 0.25 mm i.d., film thickness of 0.25 im). The methyl esters were extracted in 0.5 mL of 3× *n*-heptane and 1 iL was injected into the gas chromatograph using helium as the carrier gas at a flow rate of 1.2 mL /min. Initial temperature was 75°C for 1 min and this was followed by an increase of 30°C/min to a final temperature of 182°C that held for 8 min at this temperature and then increased further to 200°C and held for 1 min.

Statistical Analysis: Performance and fatty acid data were analyzed by analysis of variance as a 2 × 2 + 1 randomized complete-block design by using the MIXED procedure (SAS Inst. Inc., Cary, NC) [17]. The GLM procedure of SAS was used for performance and FA data. Means and contrasts were considered significantly different when the F-test < 0.05.

RESULTS

Animal Performance: The animal performance is presented in Table 1. Dry matter intake significantly ($P < 0.05$) decreased in groups supplemented with 4% oil sources in as compared to control (CO=5.43, SO=5.34 and RWO=5.40 vs. control=6.07). DMI of animals fed from 2% canola or sunflower oils were not significantly decreased than the control group (5.9 and 5.8 vs. 6.07, respectively). Lipid source did not significantly influence growth rate but, DWG tended to be improved for steers fed diets containing 2% RWO, followed by 2% so compared with performance of steers fed other experimental diets.

Fatty Acid Proportion: The fatty acid composition, as predominant and total saturated and unsaturated fatty acids (TSFAs and TPUFAs) and also, TSFA: TPUFA ratio is shown in Tables 2. Intramuscular saturated and unsaturated fatty acid contents was significantly ($P<0.05$) different among treatments with 2 and 4% of oil origins (CO, SO and RWO) added to bulls diets. The TSFA and TPUFAs ratio was therefore, affected in groups adjusted to oils sources. The SFAs contents of steaks of bulls fed diets supplemented with 2% CO did showed the lowest value and followed by 2% SO dietary groups. Also, bulls fed 4% CO had third rank from the point of view the lower SFA deposition of meats. Similar to total SFA content of steaks of groups 2% CO and 2% SO, their total PUFA content did showed the significant different than other

Table 1: The feed intake and daily WG of performance in bulls (kg/day)

Treatments	feed intake (g) daily	WG (g)
Control	6067[a]	1040
CO		
2%	5903[a]	1021
4%	5433[b]	1002
SO		
2%	5800[a]	1080
4%	5344[b]	954
RWO		
2%	6070[a]	1121
4%	5400[b]	950
SEM	152	84
P-value	*	ns

Values are expressed as the mean and their SEM for three animals in each group; WG = weight gain; CO= canola oil; SO=sunflower oil; RWO= restaurant waste oil; *=P<0.05

Table 2: The fatty acid proportion of bull steaks, as total saturated and unsaturated fatty acids and TSFA: TPUFA ratio (%)

Treatments	TSFA	TPUFA	TSFA:TPUFA
Control	51.01^{a}	37.66^{c}	0.97^{b}
CO			
2%	32.12^{d}	52.08^{ab}	0.64^{a}
4%	46.99^{b}	39.70^{c}	1.21^{b}
SO			
2%	39.28^{c}	53.08^{a}	0.75^{ba}
4%	41.55^{a}	43.20^{bc}	0.96^{b}
RWO			
2%	46.02^{b}	41.56^{c}	1.10^{b}
4%	51.38^{a}	38.84^{c}	1.32^{b}
SEM	2.11	1.85	0.07
P-value	**	**	**

Values are expressed as the mean and their SEM for three animals in each group; TSFA: TPUFA = total saturated fatty acid: total polyunsaturated fatty acid ratio; CO= canola oil; SO=sunflower oil; RWO= restaurant waste oil; *= P<0.05, **= P<0.01.

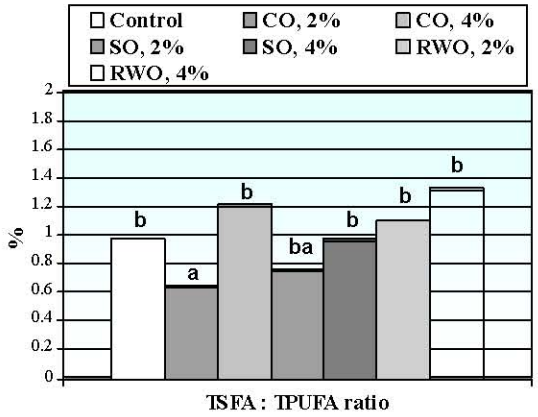

Fig. 1: Values of figures are correspondent to those shown in Table 2. TSFA: TPUFA = total saturated fatty acid: total polyunsaturated fatty acid ratio; CO= canola oil; SO=sunflower oil; RWO= restaurant waste oil.

groups, but unlike SFA, the highest values of PUFA were observed in these groups ($P < 0.01$). The lower SFA and higher PUFA level in tissue cause a reduced ratio of TSFA: TPUFAs of bull steaks with diet supplementation by 2% of canola or sunflower oils.

DISCUSSION

Incorporation of lipid into the diet did not influence DM intake, although there was a tendency for intake of the 4% oils diet to be lower. Chilliard and Doreau [18] reported a reduction of 1.6 kg DM per d when dairy cows fed on maize and concentrates were supplemented with 300 ml of fish oil (menhaden type) and similar effects have been observed elsewhere [2, 19]. It is thought that these effects are mediated by specific fatty acids produced as a result of rumen biohydrogenation rather than a negative effect of the fatty acids of fish oil on rumen function, since the fish oil does not disturb ruminal fibre digestion [18, 19]. Since intakes were similar across treatments of similar nutrient balance, no significant differences in live weight gain were expected (Table 1).

In current study, groups 2% CO and SO have lowest SFAs and highest PUFA levels. Despite the high degree of biohydrogenation of dietary PUFA reported by Scollan *et al.* [20] and by Doreau and Ferlay [21], supplementation with PUFA-rich rations (2% oil level) in the present experiment resulted in a decrease in the SFA and an increase in the PUFA proportion in the muscle. This decrease in SFA suggests an increase in the incorporation of PUFA in muscle at the expense of SFA, due to the different proportions of fatty acids and oil levels in the unsupplemented and supplemented diets.

Oil supplementation decreased further the proportion of palmitic acid as a reflection of the greater level of PUFA in the diet. This represents a nutritional improvement compared with the tissues from animals fed exclusively on pasture. Mir *et al.* [12] reported an increase in PUFA and a decrease in SFA such that the SFA: PUFA ratio in muscle decreased when steers were supplemented with sunflower oil on a DM basis. Similarly, Madron *et al.* [22] decreased the SFA:PUFA ratio in muscle by feeding extruded soybeans, also rich in C18:2n-6. The PUFA:SFA ratio in muscle achieved in this experiment with the SO treatment, although lower than current recommendations [23] is among the greatest reported for cattle fed unprotected fat sources. Realini *et al.* [24] and Duckett *et al.* [25] recognized that the fat concentration of muscle has a major influence on the SFA: PUFA ratio because PUFA are mainly found in the polar lipid fraction, which is diluted by the growth in the neutral lipid fraction as animals accrete lipid. Mir *et al.* [13] also found a significant increase in the total PUFA in muscle due to the increased incorporation of C18:2n-6 in the muscle for cattle supplemented with sunflower oil. Feeding LO similar to CO from the point of view PUFA and n-3 series levels, however, increased the n-3 PUFA proportion in muscle. Comparisons of the PUFA:SFA ratio across studies should therefore be made with caution because lean animals will have a lesser SFA: PUFA ratio irrespective of ration composition [25]. In the presented study, the lower SFA and higher PUFA levels in tissue cause a reduced ratio of TSFA: TPUFAs ratio of bull steaks with diet supplementation by 2% of canola or sunflower oils (Figure 1).

It is recognized that an increase in the concentration of PUFA was achieved in the current study by CO and SO in 2% oil levels that could ensure the recommended consumption of PUFA from animal tissues, daily (Institute of Medicine of the National Academies, [27]). Thus, 200 g of fresh muscle produced from bulls supplemented with canola oil or sunflower oil in the current study would provide with consider to recommendations of International Life Sciences Institute [28] in the human daily requirements to PUFAs intake.

In conclusion, this study demonstrated that supplementation of bulls with vegetable oils rich in polyunsaturated fatty acids in 2% levels led to a substantial increase in polyunsaturated fatty acid compared with control or other groups by different oil or in 4% levels.

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